Master's Thesis Engineering Technology

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Programming a motor testbench with a MOVI-C controller

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Master of Energy Engineering Technology

Introduction:

This master thesis was created by Vanderlande to fulfil the desire to test motors in house. This started with a mechanical-design of which the build started mid-2018. This thesis starts from the delivery of the build till a functional testbench that can measure the slip, power factor, current, efficiency and in/output power of the motor on test. This to measure motor characteristics, torque-speed characteristics, efficiency and endurance of the motor powered with or without a drive. The focus of this thesis lays on hardware and software.

Motor choice:

The fixed motor is the motor that serves as load. Two fixed motors (1) are chosen to allow the largest coverage in motors to test. The motor with the highest torque has 500Nm torque and the motor with the highest speed has 615RPM. The motor "R37 CMP71L" (for low speeds) is chosen because it has the highest output torque that fit in the provided space. It has two maximum torque setpoints, one for short usage and one for long testing (endurance test). The motor "CMP80L" (for high speeds) also has these two maximum torque setpoints, these are to allow sufficient cooling of the motor.

The fixed motors are also equipped with an encoder to measure the speed of the motor on test (2), which is necessary to calculate the output power of the motor.

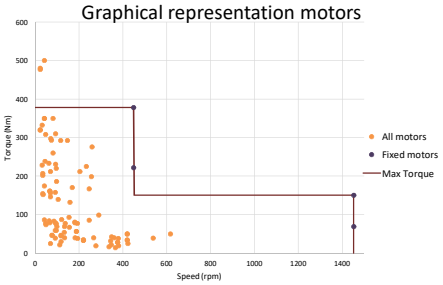

Figure 1: Motor testbench

Program:

The program is written in Codesys (a manufacturer-independent development environment for PLC) and contains multiple blocks. The main block, where the application starts and checks if all data is available to start the chosen test.
The program block, associated with the test (Torque-Speed test, Motor characteristics test, Efficiency test or Endurance test) that will be executed, will power the motors and read the necessary data.
When all data is collected the last program block is called to write all data to the Cfast card. The data is written as an Excel file and can be extracted with a pc that is connected to LAN3 of the controller or with a Cfast card reader.
An Excel macro can be used for a better graphical representation. This macro pops up a file finder. If a test file is selected the macro will create a layout a standard layout and depending on the test (this is written in one of the cells) will create different graphics.

Power measurement module:

The Beckhoff EK1100 is chosen as the Ethercat coupler to add slaves on. The main advantage of using a Beckhoff device in combination with a MOVI-C controller is that they both use Ethercat which is developed by Beckhoff. The Beckhoff EL3403 power module is chosen to measure the consumed electrical power. The output power is measured by torque and speed. The torque is measured with a DRFL torque sensor that has an output of 10V DC with a maximum torque of 500Nm. While the speed is measured on the fixed motor. To measure the torque an analogue input module (EL3602) was added to the Ethercat coupler (EK1100).

Results

Today Vanderlande has a motor testbench that can measure the motor characteristics and torque-speed curve of the motor, the efficiency of the motor with a drive. They can also conduct a test that simulates the motor powering a conveyer belt, this test is the endurance test. Examples of these test results can be seen in the figures below. These tests where conducted with a 550 watt NORD motor that was equipped with a gear unit, therefore the output speed and torque of the motor where 205Rpm and 26Nm.

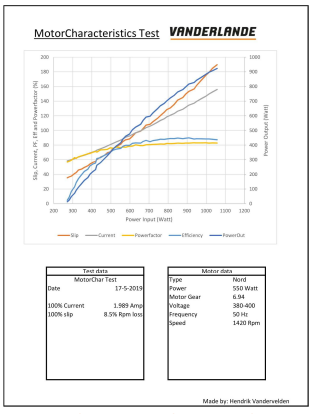

Figure 3: Motor characteristics test with a 550 Watt Nord motor

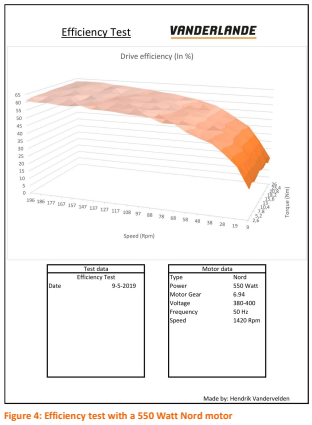

Figure 4: Efficiency test with a 550 Watt Nord motor

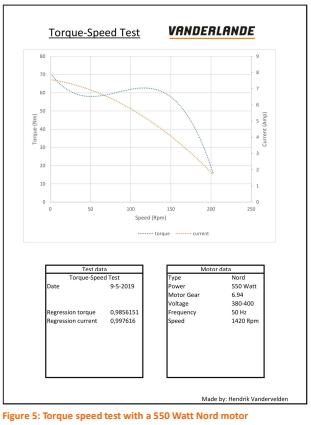

Figure 5: Torque speed test with a 550 Watt Nord motor

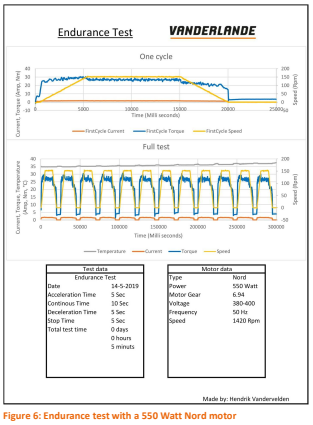

Figure 6: Endurance test with a 550 Watt Nord motor

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